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Status of the miniBETA experiment.

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Outline

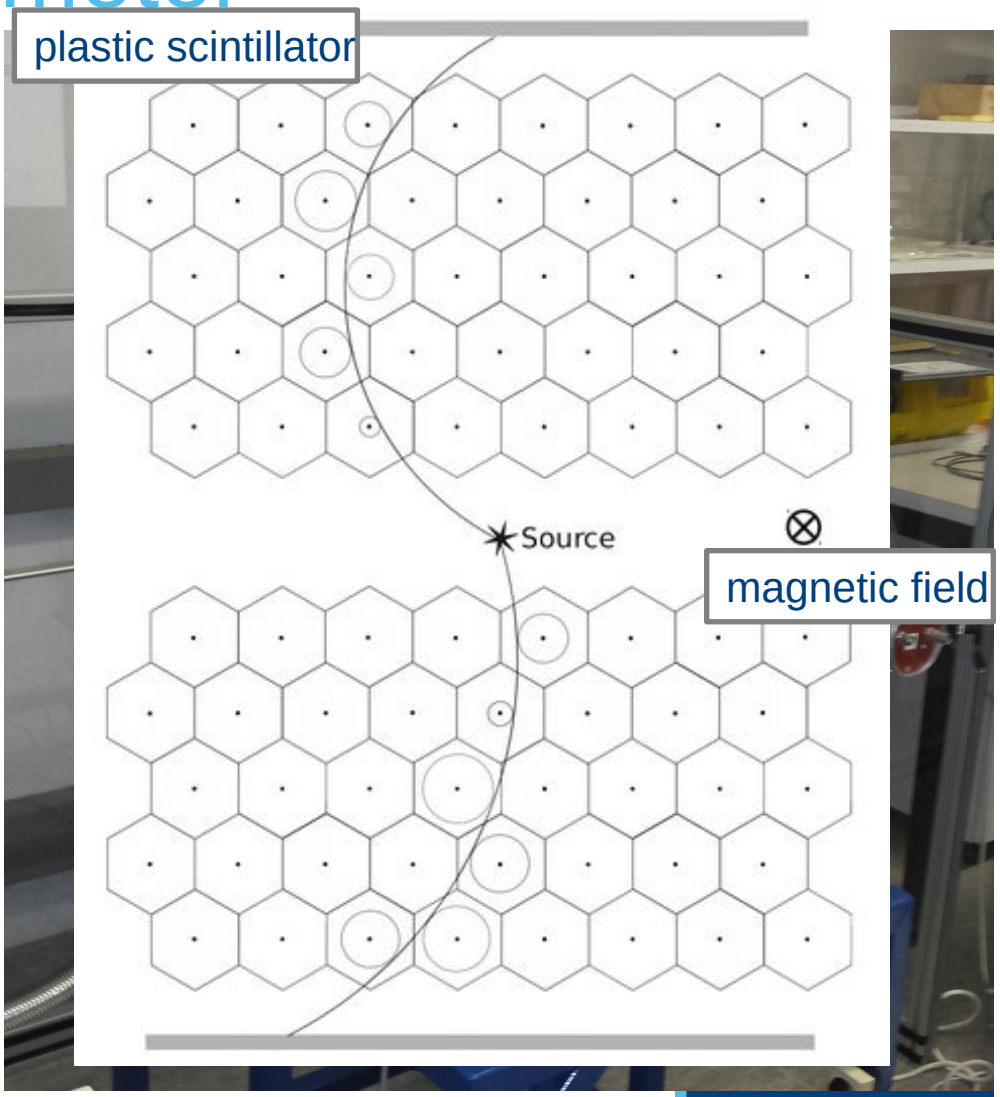
- miniBETA spectrometer
- Optimization of the efficiency:
  - single plane HV scans
    - miniBETA and FASTER DAQs
    - discrepancies with the simulation
- Scintillators characterization
  - Scintillator energy and position efficiency dependency
- Summary and future plans

miniBETA spectrometer

-Modular reconfigurable drift chamber
-beta source inside
-energy from curvature of trajectory in mag. field (~0.01T)
-trigger from scintillators (start signal for TDC)
-operates with light gas at low pressure (~300mbar)
-80 hexagonal cells (10 signal planes with 8 wires)
-X-Y space resolution 0.5mm
- Z position from charge division

Goal:

Precise measurements of β −spectrum - compare with SM looking for New Physics



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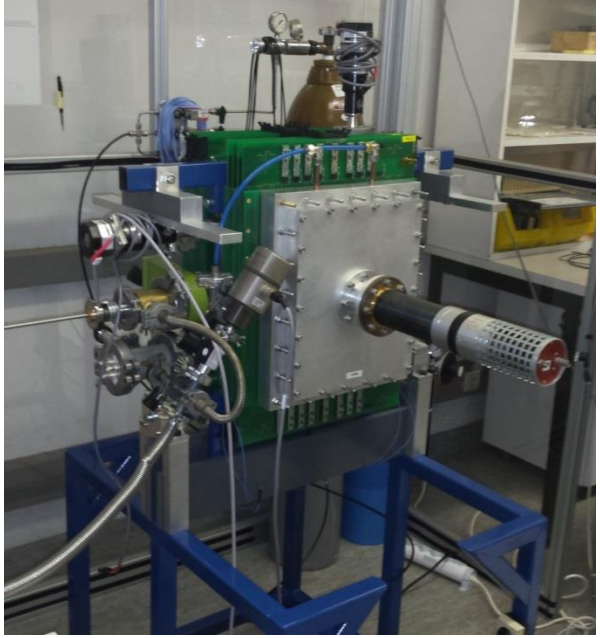
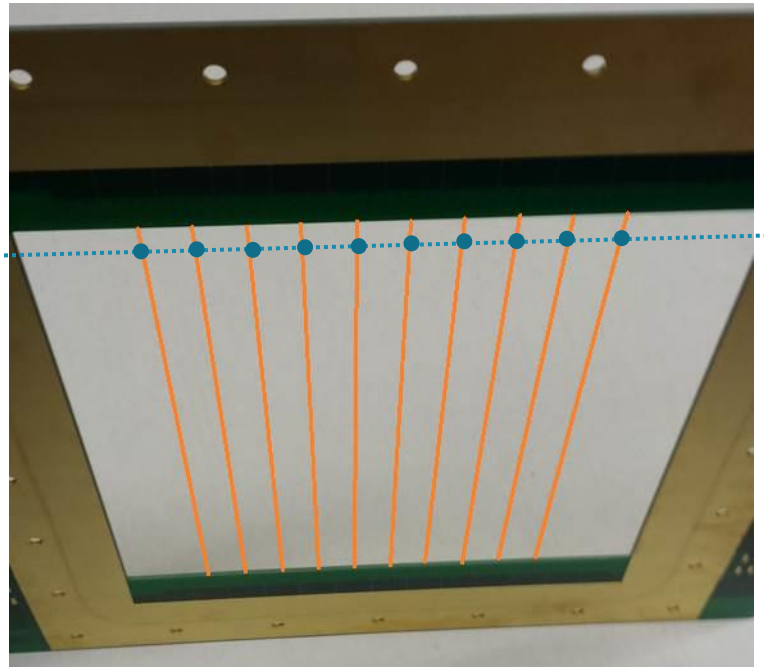
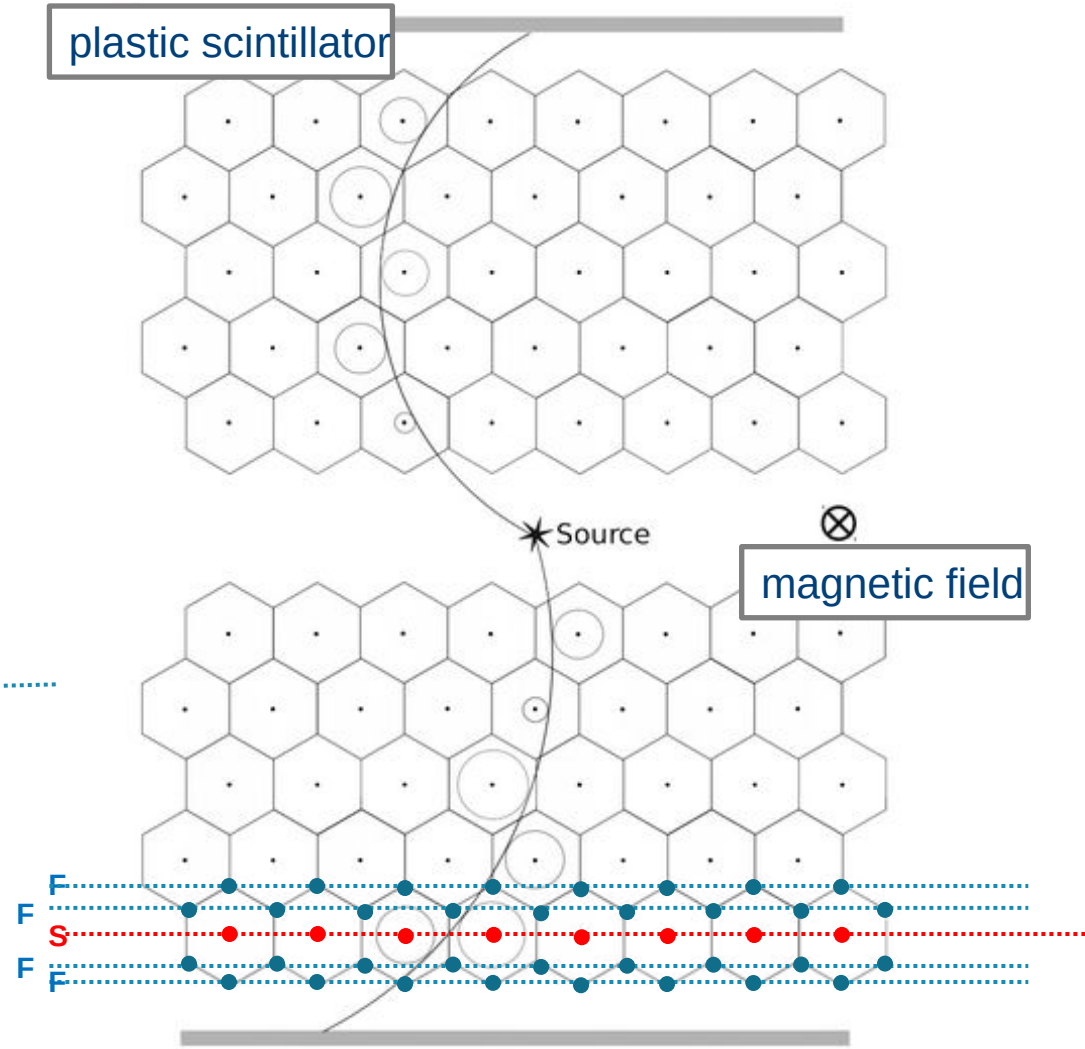





plastic scintillator
Source
magnetic field
F
F
S
F
F

Efficiency optimization:

Very high single cell efficiency e required for proper track fitting:

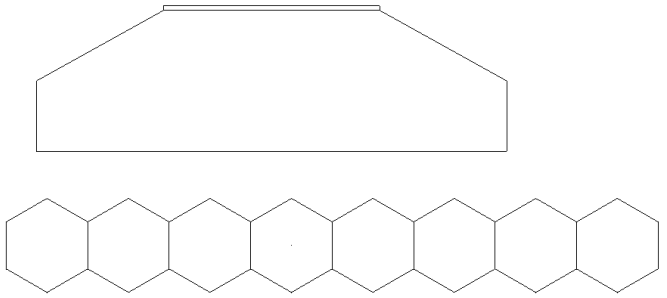
$$E = e^x$$

E – chamber eff.
x - number of cells

If $E > 90\%$, $x = 5$ then $e > 98\%$

e depends on the conditions inside the chamber:
gas mixture, pressure, electric field (voltage applied to the wires) …

Single plane HV scans.



HV scans: gas mixture and pressure fixed, changing the voltage on the wires.

Tested mixtures of helium – isobutane: 0-100%, 50-50%, 70-30%, 90-10%
at 300 mbar and 600 mbar

Two DAQ system used: miniBETA dedicated one and FASTER

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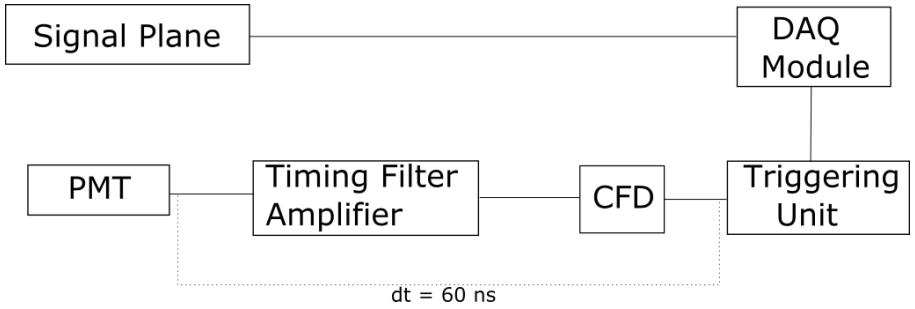
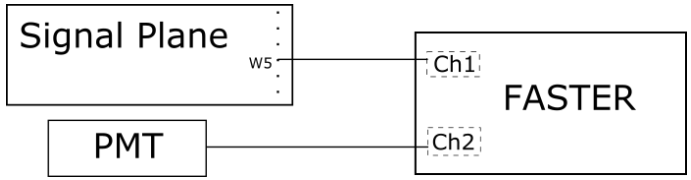
miniBETA setup



- PMT signal needs amplification and translation into logic pulse.
- Only coincidences recorded:
  - time stamp, TDC and ADC.

FASTER setup



- 2 channels recorded individually:
  - time stamp,
  - ADC.
- Coincidences found offline:
  - $TDC = time_2 - time_1$,

  if: $(time_2 - time_1) \in (T_{min}, T_{max})$

Results obtained with both DAQs were compared.

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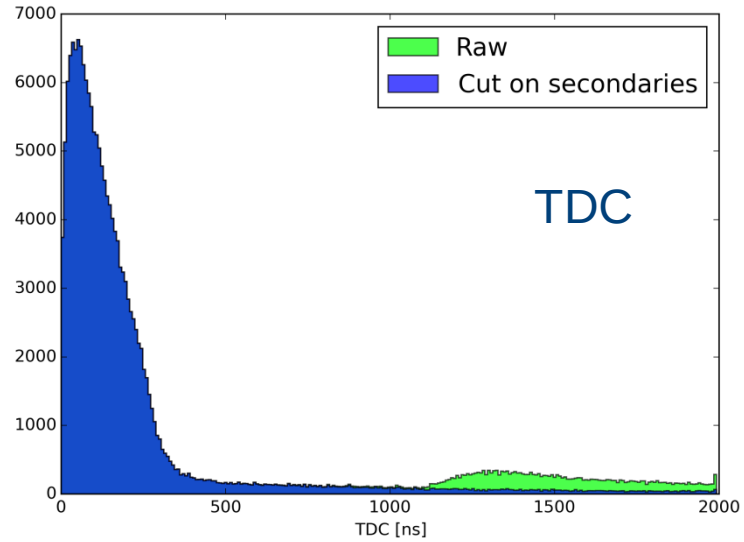
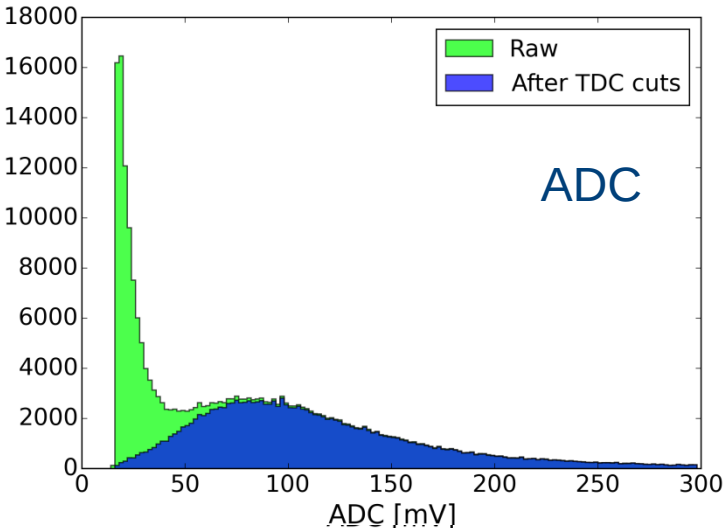
He-Iso 70-30% @ 300 mbar, 1580V

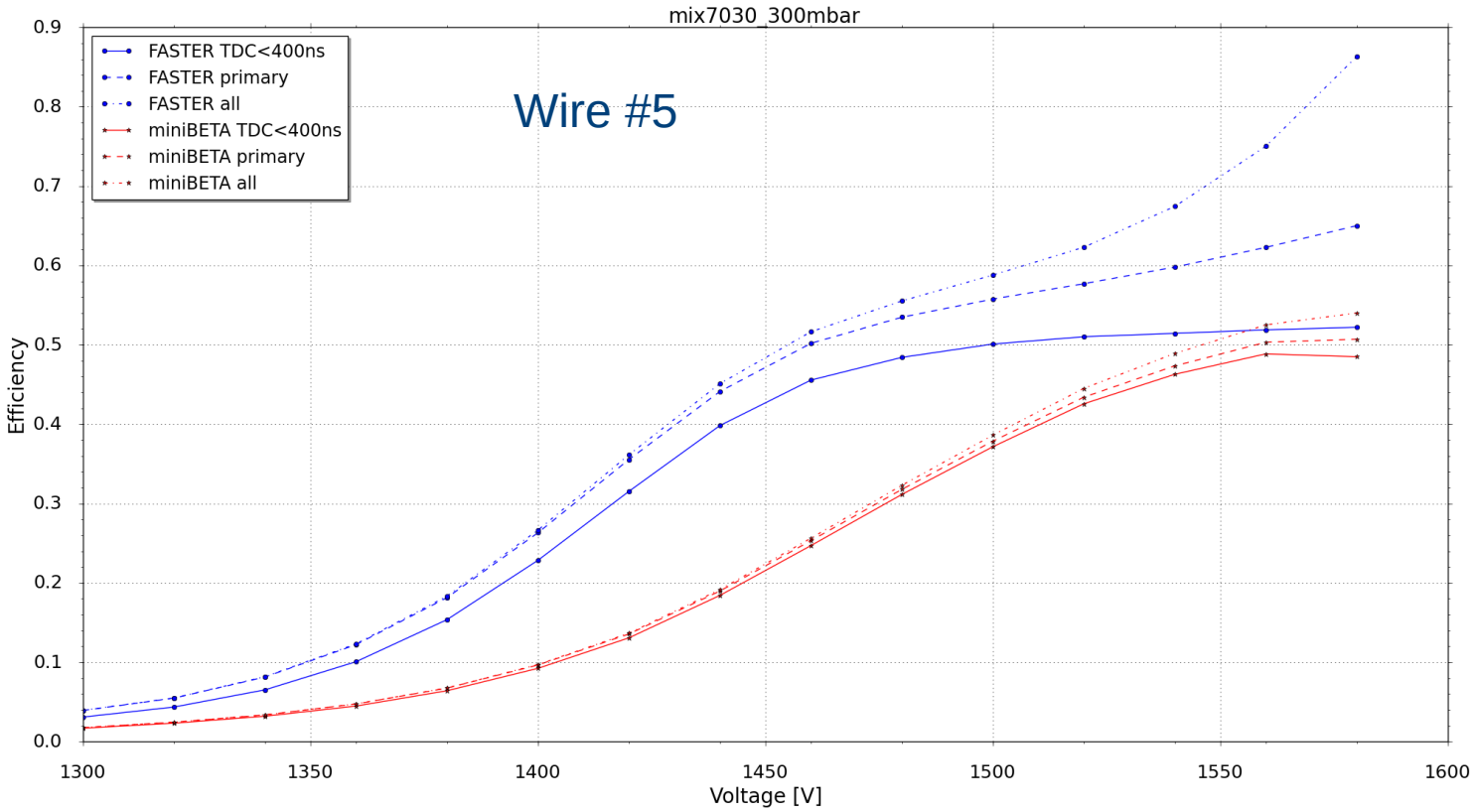




Necessary cuts:

- Secondaries
- TDC > 400 ns

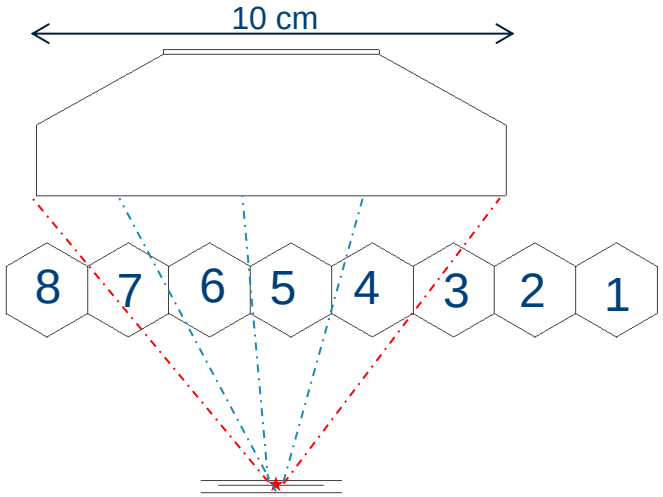
He-Iso 70-30% @ 300 mbar

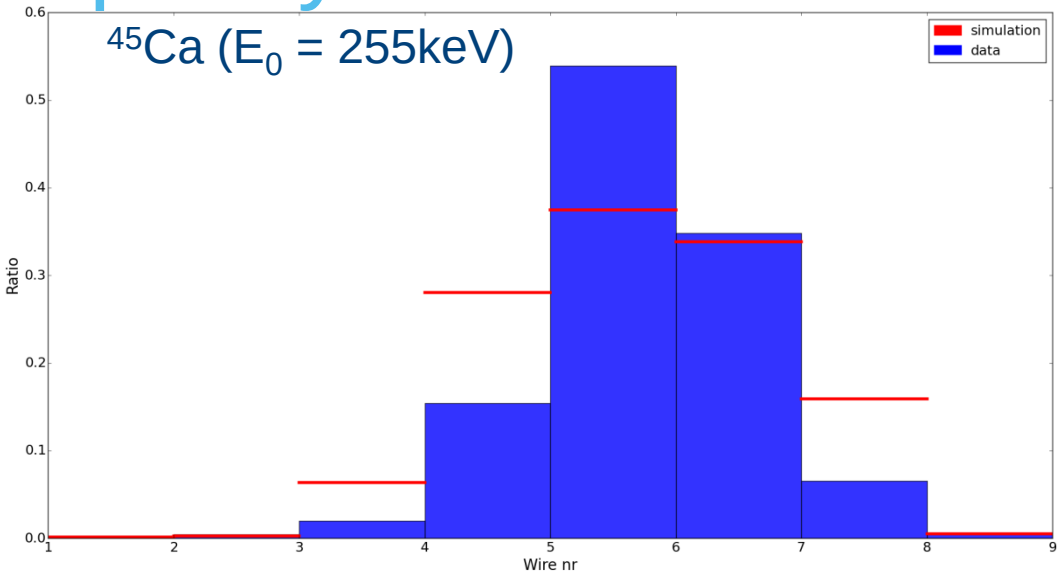


$$e = \frac{N_{coincidences}}{N_{triggers}}$$

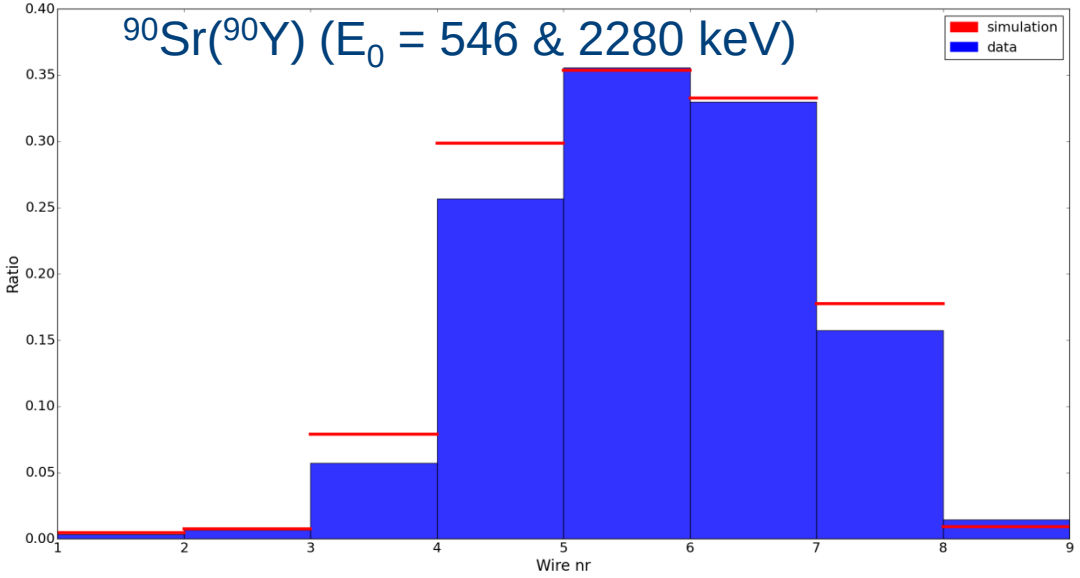
Geometry not included

Efficiency discrepancy with simulations

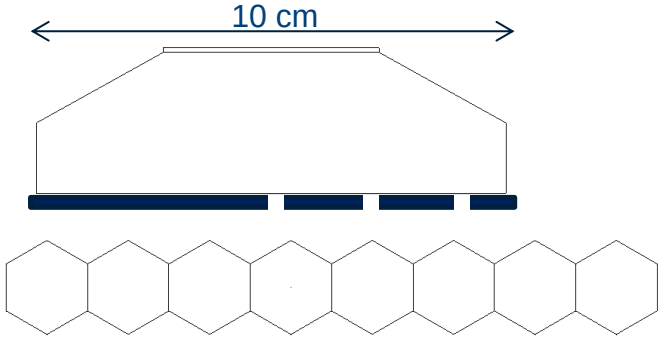




$$e_i = \frac{N_i}{N_{all}}$$



Scintillator energy and position efficiency dependency



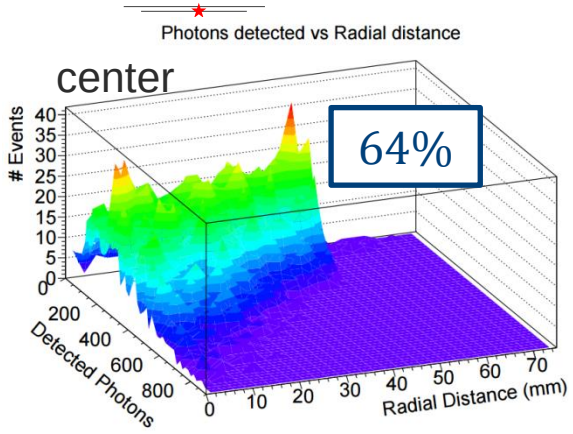
Measuring counting rates with different masks:

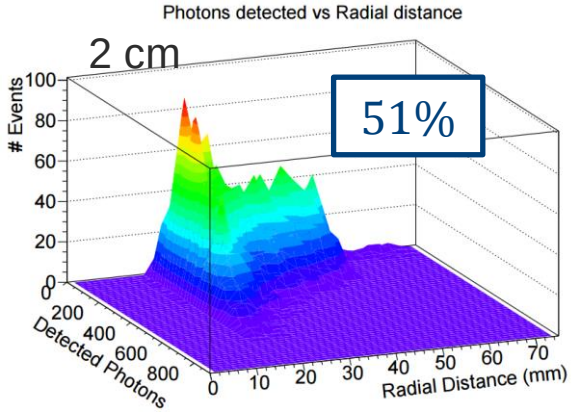
- slit at center,
- 2 cm away
- 4 cm away,

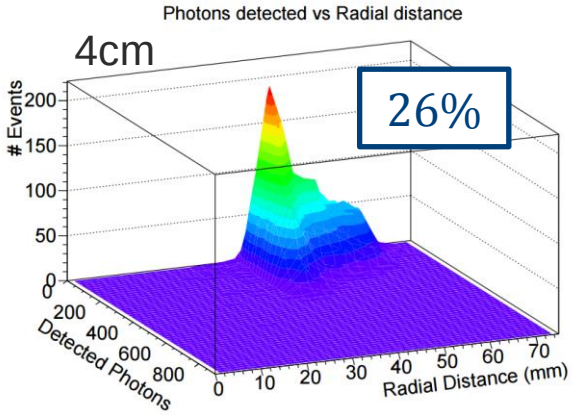
At the edge only 40% (!) efficiency relative to the center for ^{45}Ca (90% for ^{90}Sr)

Electrons from ^{90}Sr produce more photons
→ higher chance of detection.

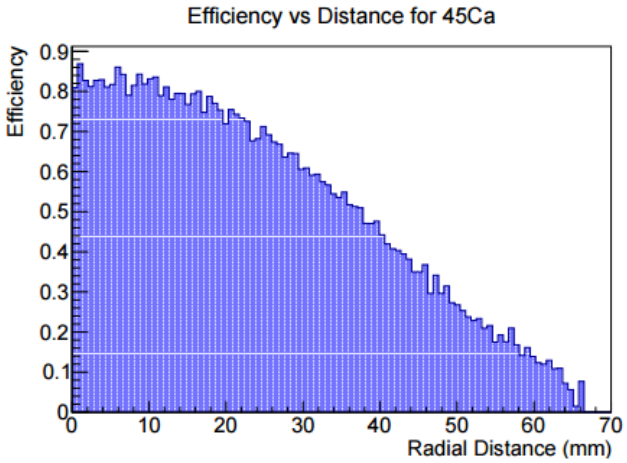
Scintillator from polyvinyltoluene with short absorption length 43mm.

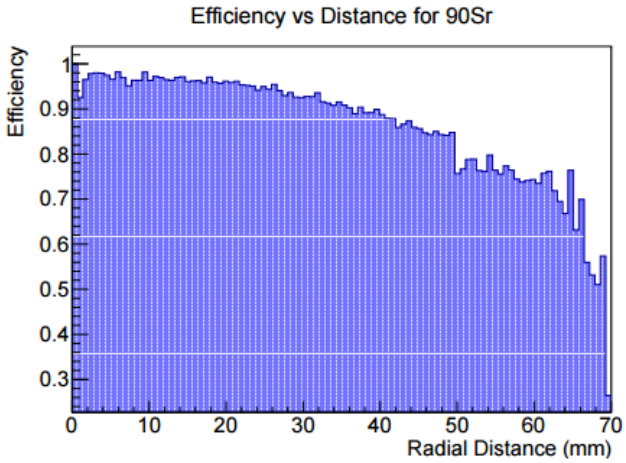


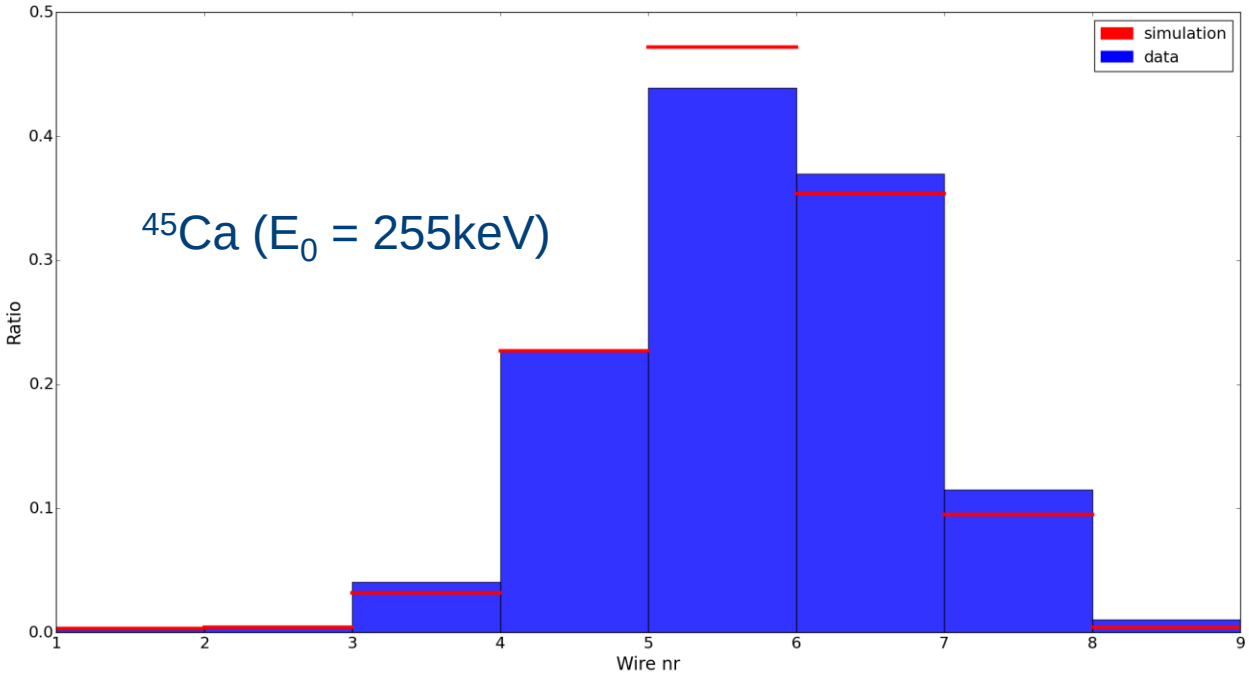




Required # photons >150: nice agreement of simulations with measurements.







^{45}Ca (E_0 = 255keV)

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Summary:

- Maximal detection efficiency is very similar for different gas mixtures, but different V is required.
- Results for FASTER and miniBETA DAQs are converging;
  - miniBETA requires higher V, probably signal height threshold issue.
- Efficiency of our scintillators are highly energy and position dependent (for ^{45}Ca up to 60% losses at edges).

(Near) Future plans:

- Scans with multiple planes:
  - Track fitting:
    - proper efficiency
    - spatial resolution

Thank you.

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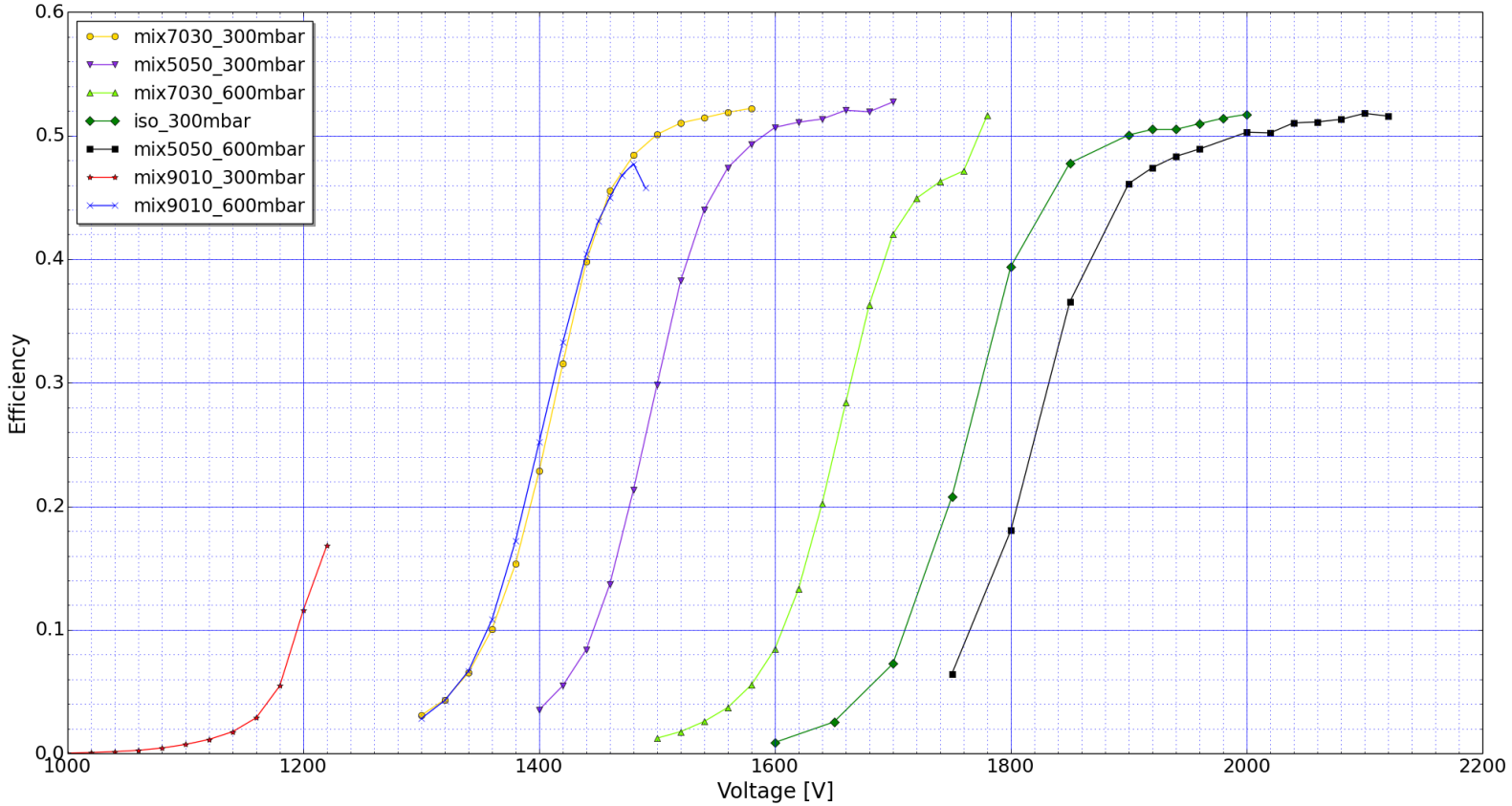
Efficiency as a HV function.



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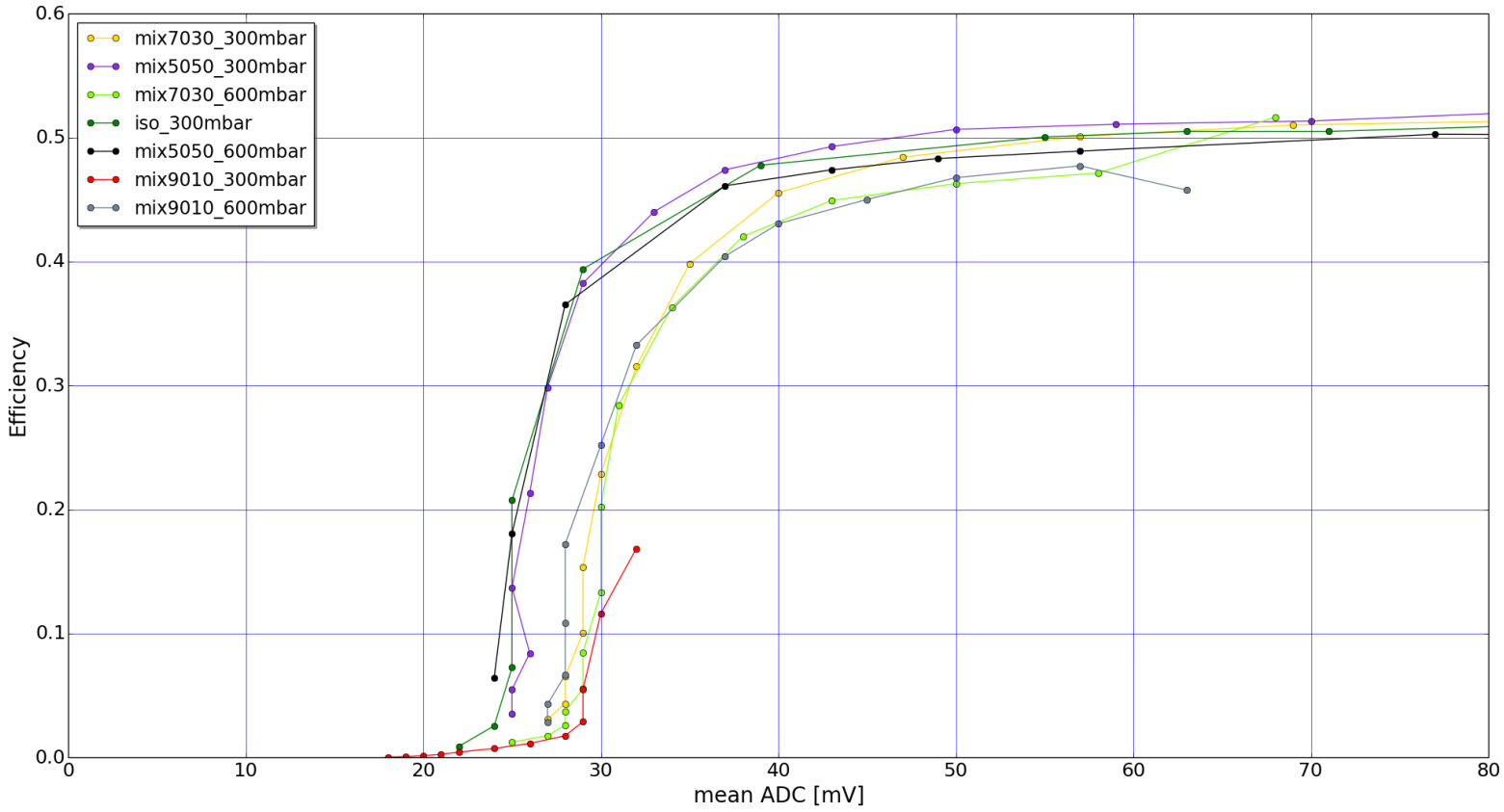
Efficiency as a signal height function.



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